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Assessing the Reliability Impact of a Regional Transmission Organization (RTO)

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Assignment

At the request of Vickie Van Zandt, Vice President of Transmission Planning at the Bonneville Power Administration (BPA), we rapidly analyzed the potential reliability impacts of establishing an RTO in the northwest part of the United States. The work spanned less that two months of time, and was conducted in a series of meetings in Vancouver, BC, a Relative Reliability Effect Analysis session in Pullman, WA, a briefing in Portland, OR, and report preparation in Pullman.

Re-regulation of the U.S. utility industry is well underway, with the changes being driven by Federal Energy Regulatory Commission (FERC) orders and deadlines. One of the difficulties in assessing reliability impacts of an RTO is keeping in mind exactly where we stand today. We no longer have a vertically-integrated utility structure, i.e., Generation, Transmission, and Distribution inside a single company franchised in a single geographic area.

We have moved to a state where generation is rather deregulated. The transmission assets continue to be regulated and operated by regional franchisees, in general. Here in the Northwest, the Bonneville Power Administration network crosses the boundaries of the franchisees and handles much of the transmission of electric power.

Planning used to be a company activity, coordinated in the region between companies. This planning was holistic within the franchised company--covering generation, transmission, distribution, and the needs of customers. Today, individual generators are developing their plans in private, and are expecting the transmission grid to handle the power.

Given that FERC has directed the industry to come up with four to five RTOs covering the United States, it seems that there is little choice but to form RTOs. Consequently, this analysis mainly assumes that an RTO will be formed, and attempts to identify where difficulties may be experienced. We have also taken a first estimate as to how to mitigate any difficulties.

Therefore, we stress that this report is not a pros-vs-cons-of-an-RTO discussion. Instead, the report attempts to determine the impacts and risks in moving from the present hyper-state in the re-regulation process, towards a state envisioned by FERC, where deregulated generators supply energy into a more regulated transmission system/marketplace, and where this transmission system would be managed by a new organization, above the existing organizations of the utilities owning transmission today.

Another present characteristic to keep firmly in mind is that essentially no new transmission has been built in the past 15 years, and the once-conservative system is now stressed at several points. A once-supple system is now brittle.

Fortunately, BPA finally received Congressional approval to borrow $750M of the $2B it requested to build more transmission. Just as fortunately, it appears that the bottleneck at Path 15 will be relieved with about $30M of new transmission.

Thus, our approach was to try to understand the present situation, and estimate risk factors that could affect the reliability of the power system as we move towards an RTO. Identifying and solving major problems early reduces the likelihood of any negative impact on system reliability of moving from the present state to an RTO-operated system.

BPA engineer Bill Mittelstadt suggested that we consider a list of about a dozen factors that would be affected by an RTO. The authors of this section of the report expanded the list to around 46 issues, and prepared to analyze the reliability importance of each of these factors.

Finally, this is not a political document. This is a risk assessment, with suggestions on possible mitigations of risk. In making any change in organization, risk is involved in transition – even if every change were to ultimately be for the better. We believe we have identified the major risks in making a change to an RTO, and have also found some ways to mitigate the risks, so that, whatever decisions are made, a quality, reliable result is attained.

Local Factors Affecting System Reliability

Changing management of the Northwest Power Grid will not automatically increase the load carrying capability of the network shown in Figure 1. The Northwest Power Grid (Grid) is very different from East Coast grids in that it covers a larger geographical area with most large load centers being great distances from the major power generation sites. Transportation of power in the Northwest occurs across a highly utilized, high voltage system of power lines. Proper operation of this transmission system grid is paramount to reliability. The effect of poor grid care and operation can result in widespread blackouts.

Figure 1 Map of Western States Major Transmission Lines

The large geographical area covered by the power grid means that the lines have great exposure to phenomena that can cause system faults (e.g., weather, vegetation overgrowth, etc.). When a line becomes faulted, the affected equipment must be removed from service. A single contingency loss of an apparatus must not destabilize the network such that the original disturbance cascades into the loss of an even greater portion of the power system. How the power system is operated and maintained has a great effect on how the utilities can localize and isolate only the effected apparatus.

How a power system responds to an incident depends largely upon many factors: generator loading, generator reserve, actions of the apparatus control systems and the dispatch operators. System reliability suffers when any part of this system fails to act properly.

For example, in 1996, the West Coast Power Grid suffered a severe disturbance. This disturbance affected thirteen states and provinces. The initiating event was really no different from many other previous incidents: a 500kV line faulted and was removed from service. For the next hour, the redistributed load currents overloaded lines. This eventually led to cascading outages.

Methodology

Ed Schweitzer (EOS) discussed possible methodologies of analysis with Ron Schwartz, Vice President of Quality at SEL. Ron suggested we apply the techniques of a Failure Mode Effects Analysis. In such an analysis, each issue is evaluated in three ways: severity, likelihood of occurrence, and likelihood of going undetected. Suppose we assign variables S, L and U, and then assign values to each variable for each issue. Then, for each issue, the risk priority is P = SLU.

EOS discussed this methodology with Ron Schwartz, and recommended a modified approach, not based on failure modes per se, and more suitable for comparing the relative effect of two different system designs and of transition from one system to a new one. In our case, the two system designs are the existing transmission operations, and a new operations with an RTO.

EOS and Ron Schwartz named the approach a Relative Reliability Effect Analysis. We decided to state a characteristic of an RTO, which contrasts it from today's organization; and then rate the reliability effect from –5 to +5, depending on whether the characteristic relatively reduces or increases reliability of the transmission system. We weighted each characteristic from 1 to 5, to rank the likelihood of occurrence, and multiplied the rates times the weights. So, each issue ended up with a possible score of from –25 to +25.

EOS collected a group of SEL personnel with the following backgrounds:

- Senior Protection Engineer, with experience at Bonneville Power Administration (BPA) and Pacific Gas & Electric (PG&E)
- Senior Protection Engineer, with experience at Chevron Oil Co. and PG&E
- Public Relations Manager, with legislative experience at the national and state levels, and with the benefit of recent experience concerning investigations into political activities involving utility deregulation
- Senior Electrical Engineer with experience in protection, metering, and research in several companies and at EPRI
- Senior Reliability and Quality Systems Engineer, with experience in a broad range of industries and organizations, including manufacturing, government, consulting and senior management
- Business Executive, familiar with all facets of SEL business, and years of experience tracking deregulation in our and other industries

EOS presented the following concepts to the group, so that the group had a common understanding of the present and the potential new situation (with the RTO), so that the two could be compared by the analytic method previously described.

FERC consists of presidential appointees. They mandated open access to transmission, and that four to five RTOs should cover the USA. The concept is a highly regulated "national grid" marketplace for unregulated generators to connect anywhere, to insert energy.

Distributors buy from the grid to resell energy to their end-users.

At present, in the RTO West area, there are about twelve electrically-interconnected utilities. They are relatively loosely coupled by interchange agreements.

Common issues are planned and discussed in the Western System Coordinating Council. Regional Coordinating Councils meet and plan at a national level via the North American Electric Reliability Council.

The concept under consideration for RTO West is a strong RTO. The utilities continue to own the assets, but RTO West operates the assets for the most part.

It is highly probable that NERC would set rigid standards for all RTOs to follow, and that these standards could some day have the force of law.

A web-based software system called OASIS (Open Access Same Time Information System) would be used for pricing and trading.

In summary, the RTO would centralize the planning and operation of most of the transmission assets still belonging to the individual companies.

Issues Evaluated in the Pullman Meeting

EOS reviewed the entire list of issues with the group described earlier. The purpose of reviewing the list first was so that all participants would have a broad enough perspective to assign relative weights to issues. He then led the group to consider each issue, one at a time, and assign a rate and a weight to each.

Table 1 lists the issues rated and weighted by the group, and shows the product of the rate and weight for each issue. Since our mission is to attempt to identify potential reliability issues, we took a critical point of view, looking for potential reliability impact in making the change. Therefore, most of the rated scores were negative.

For instance, "RTO puts capital where it does the most good" received a weight of 5, and a rating of –5, for a product of –25. The group's concern is that it could be a long time before RTOs, utilities, investment analysts, advisors, and FERC get everything figured out to the point where investors are again comfortable buying stock in utility transmission assets.

A positive example is "RTO develops on-line voltage and dynamic security tools," which received a weight of 3 and a rating of 3, for a product of +9. In our discussion particular to this point below, we note an RTO is not necessary to achieve this, however.

Strongly negative scores indicate the greatest risk factors the group foresees, and are the areas that should receive the most attention.

Within each of the eight categories, the lists are prioritized with the most significant negative impact on reliability listed first.

Table 1. Pullman Meeting Issue List

		Rate	Weight	Product
	Planning Characteristics of RTO			
1	RTO puts capital where it does most good	-5	5	-25
2	RTO operates safety nets to limit cascading	-4	4	-16
3	RTO develops system wide stability control measures	-3	3	-9
4	RTO reviews generation access request in timely manner	-2	2	-4
5	RTO screens entire system every two years	-2	1	-2
6	RTO determines safe operating limits	1	1	1
7	RTO collects system statistical data	1	1	1
8	RTO reports region load and resource data--poor now.	1	1	1
9	RTO applies uniform system-wide modeling	1	1	1
10	RTO applies uniform reliability criteria	0	1	0
11	RTO uses compatible, efficient planning tools	0	1	0
12	RTO develops system base case.	0	1	0
13	RTO recognizes need for long range planning	0	0	0
	Operations Characteristics of RTO			
14	RTO operators are familiar with system	-4	3	-12
15	RTO manages differences between plan and operations	-1	1	-1
16	RTO coordinates scheduled outages	-1	1	-1
17	RTO coordinates main grid with subtransmission system	0	0	0
18	RTO arms Remedial Action Scheme at right time	1	1	1
19	RTO determines safe operating limits	1	3	3
20	RTO develops and operates on-line voltage, dynamic security tools	3	3	9
	Maintenance Characteristics of RTO			
21	RTO standardizes ROW clearing	-2	2	-4
22	RTO develops uniform preventive maintenance practices	-1	1	-1
	Training Characteristics of RTO			
23	RTO has broader scope for operators	-3	2	-6
24	RTO has broader scope for maintenance	-3	2	-6
25	RTO has broader scope for planners	-3	2	-6
	Security Characteristics of RTO			
26	RTO is single point of control of InfoSec	-5	5	-25
27	RTO is additional point of InfoSec	-5	5	-25
28	RTO is new physical entity	-5	5	-25
29	RTO involves 200+ new people's trust	-5	5	-25
	Business Characteristics of RTO			
30	RTO is new operator of transmission	-5	5	-25
31	RTO attracts capital for new transmission	-4	5	-20
31	RTO responds to need for more transmission	-4	5	-20
32	People with knowledge from utilities who work for RTO will eventually retire.	-4	2	-8
33	RTO manages owner' assets per operating agreement (lease)	-2	2	-4
34	RTO is not as close to customer as utility	-2	2	-4
35	RTOs must protect propriety of data from individual utilities	-2	1	-2
36	RTO must protect propriety of generating company data.	-2	1	-2
37	RTO is non-profit agency	-1	1	-1
38	RTO requires new resources in utility to manage lease	-1	1	-1
39	RTO will hire and train 200+ new people.	-1	1	-1
	Political Characteristics of RTO			
40	RTO will be subject to political decision making (e.g. FERC)	-1	4	-16
41	RTO will be lobbied by suppliers, environmentalists, traders and generators	-3	4	-12
42	RTO scope of control in T and D is not clear yet	-2	3	-6
43	RTO will be lobbied by new transmission owners	-1	1	-1
44	RTO will be lobbied by other special interests	-1	1	-1

	Technical Characteristics			
45	RTO more dependent on communications	-3	3	-9
46	RTO will develop, own, operate voltage, stability and short-circuit models	-2	3	-6
47	RTO will write new technical standards for region	-1	1	-1

We next discuss the eight issues receiving the highest negative scores, indicating that these issues need the greatest amount of attention to avoid reliability problems. These eight issues are listed below, and then discussed.

I.	RTO Develops System Wide Stability Control Measures	-9
II.	RTO Operates Safety Nets to Limit Cascading	-16
III.	RTO Puts Capital Where It Does The Most Good	-25
IV.	RTO Operator System Familiarity	-12
V.	RTO Is A Single Point of Control for InfoSec	-25
VI.	RTO West is a New Entity	-25
VII.	RTO West Attracts Capital for New Transmission	-20
VIII.	Exertion of Outside Forces on the RTO	-12

I. RTO Develops System Wide Stability Control Measures

A single RTO office would handle a much greater amount of work than the individual utilities, and the office becomes a single point of failure.

Today, through their voluntary work with the Western System Coordinating Council (WSCC), individual utilities develop and implement stability control measures. Each utility has a vested interest in maintaining its part in maintaining system stability as failure to do so could affect them directly. Presently, there is a significant level of effort performed at the utility level by experienced personnel who collect, process, and interpret data from their portion of the power system.

In the beginning, the RTO will have relatively new staff. This new staff would need to review existing stability measures and possibly establish new ones. Even if each staff member has a high level of experience, it will take a year, perhaps more, for the group to function as a team.

Performing stability control requires a large amount of data. In addition to tracking and collecting data, the RTO staff would have to process and interpret the data. Computing programs could assist in this effort. However, interpreting data and transforming it into information is best performed by experienced personnel. As backup to the RTO, utilities should retain their personnel for maintaining and monitoring system stability.

Training, experience, and moving slowly while present systems are maintained and new ones are proven are possible mitigations.

II. RTO Operates Safety Nets to Limit Cascading

The concern with relying solely upon centralized safety net control is based upon the required level of expertise and system understanding.

Safety nets are mechanisms that a system relies upon to minimize a disturbance or stabilize a system. Left unchecked, the effect of these events can spread and disrupt large portions of the power grid. A properly designed safety net informs the system operator of line loading before it becomes critical. In an automatic mode, these intelligent systems remove apparatus or redistribute load to avoid the condition where the system operator must wait until a device thermally overloads.

In some instances, a broader system picture could assist with safety net operation. However, if sole control lies with an RTO and its resident experts, the system as a whole could lose the benefit of having regional experts and their close understanding of details inside regional systems. The loss of such knowledge and their vested interest in system operation would make the power system more fragile and therefore less reliable.

Mitigations include training and maintaining existing systems and staff until the new people and systems are proven.

III. RTO Puts Capital Where It Does The Most Good

The concept is that an RTO provides a systemwide vantage point from which capital allocations can be made wisely. (A later point discusses attracting capital.)

If the RTO gains an active role in capital allocation, it may slow down the process of planning and development, and possibly introduce new influences that may or may not be constructive. In the old days of vertical integration, capital planning of transmission, generation, and distribution occurred together in a region.

The model of capital planning today, and under an RTO, is indefinite, and therefore a risk factor. Mitigation is achieved by making it clear how capital allocations are simply, quickly, and easily made.

IV. RTO Operator System Familiarity

Power system operation requires input. Utility operators use data presented to them in a formal fashion at work, plus the informal inputs of living close to the assets they operate, e.g., local weather forecasts, driving by transmission lines, etc.

Today, utility operators are closer to the system than would be RTO operators. RTO operators would be responsible for a much larger power system than the present utility operator and would need to process even more data. The RTO operator could be overloaded by vast amounts of data from a much larger area and system. Although the wider purview suggests better decisionmaking, the system must be designed well so that operators can respond quickly to emergency conditions, without being slowed down by the larger scope and more data. Could an otherwise non-emergency condition become an emergency because of the delay caused by data overloading an RTO operator?

Presumably, the RTO would start with operators from the utilities beneath it. They would bring their experience from their parts of the system to the RTO. Without a training program, this expertise would decline over time, as people lose their familiarity with system details and as people retire or otherwise separate.

Mitigations beyond extensive training at the RTO include maintaining significant operating resources and training within the utilities.

V. RTO Is A Single Point of Control for InfoSec

Information security is critically important to the safe operation of an RTO. Information and control actions need to move around a region of 50 million people; thus, the RTO becomes a prime target of information operations, information warfare, hackers, disgruntled employees, frustrated customers, etc. The RTO must be designed from the very beginning with the highest degree of communications and information security.

Redundancy is a two-edge sword. On the positive side, with two systems, one can fail and the other continues to operate. The negative side is that two systems mean two ways in.

VI. RTO West is a New Entity

RTO West will be a new organization, and there will be some successes and some failures as the organization takes form, people are trained, leadership is developed, and processes are developed, measured, and improved.

The processes not only include the work of running the transmission system, but also physical security, training programs, background screening of new employees, etc.

Mitigating these risks requires a slow, careful transition from existing people, processes and systems to new ones.

VII. RTO West Attracts Capital for New Transmission

The author discussed investing in utility stocks with a utility analyst at a major banking institution. The analyst advised that FERC is considering 13% profits in the Midwest, and this would be, in the analyst's opinion, a very attractive return. However until we really know how much profit the federal government will let these business entities make, and exactly how utilities are going to get paid, we must consider this issue a very high risk for power system reliability.

Speakers at the National Transmission Group Study (NTGS) workshops in Detroit, Atlanta and Phoenix have asked how the transmission system would attract capital. FERC is still considering policies of profitability in transmission.

The presenters at all three NTGS Workshop meetings saw capitalization as a serious matter. Attracting capital for improving the transmission infrastructure dominated the topics and questions in all three meetings. The industry needs to attract capital to construct new transmission lines to ensure system reliability and to achieve the goal of "open transmission."

There is no reason to expect that establishing an RTO will solve the problem of attracting capital for the new transmission we need right now. Anticipating that an RTO might help solve this problem may delay the real solutions.

Capital will flow to transmission once investors are satisfied in the balance between risk and return. The author believes a key to this is a stable business environment, where investors feel that the political factors have settled down, and where the business models are easily understood.

VIII. Exertion of Outside Forces on the RTO

RTO West will control the power system grid serving tens of millions of people. Such a power base attracts those wishing to influence the policies and decisions of RTO West.

RTO West personnel will receive input for decision making concerning routing and construction of new transmission lines, upgrading existing lines, placement of new generation, etc. We see this occurring with much the same process as new legislation where lobbyists provide input. Other possible sources of influence are:

- Power Traders: Influencing line placement could benefit certain traders.
- Environmentalists: Again, line placement is a critical concern.
- Generation Companies: Siting is very important. When new generation is brought on-line, the corresponding utility apparatus must be in-place to make efficient use of the new power.
- Federal Government (FERC): RTO West decisions and actions must be to advance and maintain the power system.

Thus the RTO becomes a new point of influence, in addition to the existing regulatory agencies and utilities.

This is very difficult to mitigate. Perhaps the best way is to ensure that any function assigned to the RTO is truly essential at that top level—thereby minimizing the number of dimensions of influence.

Conclusions

From a point of view of reliability, we have considered many factors and issues, and have identified eight as key considerations in possible reliability impact. We have suggested some ways to mitigate risk. Moving to a new top-level organization does involve transitional reliability risk, such as new systems, people, and training. There are some ongoing risks, such as the information and physical security risks that are heightened; and expecting an RTO to solve the capital-attraction problems of today's industry would only delay the solution of this key issue in building, operating, and maintaining a reliable transmission system.

As the table shows, there are some positive gains for reliability. For these to surface, we must proceed carefully to mitigate the other areas of risk.